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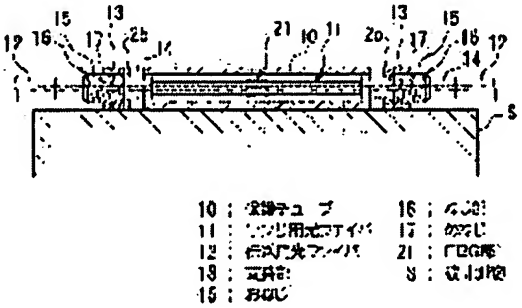
(54) STRAIN MEASURING DEVICE AND ITS INSTALLING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To enable the measurement of a highly accurate strain by very easily and highly accurately attaching an optical fiber for a sensor having a plug greeting part on a curved object to be measured.

SOLUTION: The optical fiber for the sensor 11 having an FBG part 21 reflecting light from a light source is previously inserted in a cylindrical protection tube 10 having flexibility. A screw part 16 is provided on both the ends of the optical fiber for the sensor 11. The protection tube 10 is adhered and fixed on the surface of the object S to be measured, and the screw part 16 is screwed on a support part 13. The optical fiber for the sensor 11 is expanded and contracted by rotating the optical fiber for the sensor 11, in a state that it is tightened by prescribed tension, a gap is opened to support it along the object S to be measured.



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FULL CONTENTS

[Claim(s)]

[Claim 1] The optical fiber for sensors which has a light source and the Bragg greeting part which opens a crevice, is arranged along with a thing to be measured, and reflects the light of a specific wavelength according to the degree of shrinkage of the light from said light source, [light / which was reflected in said Bragg greeting part of this optical fiber for sensors] It is the distortion measuring device which has the measuring instrument which detects elasticity of said optical fiber for sensors, and measures distortion of said thing to be measured based on the detection result of elasticity of said optical fiber for sensors. The intermediate part which said optical fiber for sensors is supported by the supporter with which the both ends were fixed to said thing to be measured, and contains said Bragg greeting part is a distortion measuring device characterized by being inserted in the tubed protection tube which has the flexibility fixed to said thing to be measured.

[Claim 2] It is the distortion measuring device according to claim 1 characterized by forming said protection tube from resin.

[Claim 3] Said protection tube is a distortion measuring device according to claim 1 or 2 which carries out that adhesion fixation is carried out by adhesion material to said thing to be measured with the feature.

[Claim 4] The optical fiber for distortion Measurement Division which connected said two or more optical fibers for sensors supported, respectively to said two or more things to be measured by the optical fiber for transmission is connected to said measuring instrument. The distortion measuring device of Claim 1 -3 characterized by detecting elasticity of said optical fiber for sensors of said optical fiber for distortion Measurement Division, respectively, and performing Measurement Division of distortion of said thing to be measured by this measuring instrument given in any 1 clause.

[Claim 5] [said supporter which the screw part which has a screw was prepared in the both ends at said optical fiber for sensors, and was fixed to said thing to be measured] By having ****** in which said screw part is screwed, and making said screw part screw in said supporter The screw of said screw part which said optical fiber for sensors is arranged along with said thing to be measured, and is screwed mutually, and ****** of said supporter are the distortion measuring devices of Claim 1 -4 characterized by being mutually considered as the

reverse screw at the both ends of said optical fiber for sensors given in any 1 clause.

[Claim 6] The optical fiber for sensors which has a light source and the Bragg greeting part which opens a crevice, is arranged along with a thing to be measured, and reflects the light of a specific wavelength according to the degree of shrinkage of the light from said light source, [light / which was reflected in said Bragg greeting part of this optical fiber for sensors] It is the installation method of the distortion measuring device which has the measuring instrument which detects elasticity of said optical fiber for sensors, and measures distortion of said thing to be measured based on the detection result of elasticity of said optical fiber for sensors. Said optical fiber for sensors is made to insert in the tubed protection tube which has flexibility beforehand. While putting said protection tube on the perimeter of the intermediate part containing said Bragg greeting part and fixing this protection tube to said thing to be measured The installation method of the distortion measuring device characterized by making said thing being measured support the both ends of said optical fiber for sensors, and making a crevice open and arrange along with said thing to be measured.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the distortion measuring device used when an optical fiber detects displacement of distortion of various structures, the foundation, etc., and its installation method.

[0002]

[Description of the Prior Art] Conventionally, in order to avoid danger, such as earth and sand and crash of a base rock, a watch stander going round and grasping a situation is performed and it is. [however, the surveillance by such a watch stander's round] Since about [being very inefficient] or accuracy is also missing, detect diastrophism, and grasping that situation is performed by the distortion gauge, and [this technology] For example, it is used also for detection of distortion of buildings, such as steel structures, such as an iron bridge, and a building, and grasping such faults in advance is performed.

[0003] However, the distortion gauge could perform only detection of a local distortion, therefore was not suitable for a long picture structure. For this reason, in recent years, the distortion measuring device which detects change of the wavelength of the catoptric light corresponding to the degree of shrinkage of this optical fiber, and measures distortion is being developed using an optical fiber.

[0004]

[Problem to be solved by the invention] By the way, although distortion of a thing to be measured is measurable by straining the optical fiber using this kind of optical fiber whose measuring device it is distorted and is that sensor by predetermined strain power along with a thing being measured, and attaching it When it had the complicated form where the thing to be measured curved the shape for example, of a U character, or in the shape of an S character, along with this thing to be measured, an optical fiber could not be arranged with sufficient accuracy, but there was a problem that highly precise distortion Measurement Division could not be

performed.

[0005] and in the attachment attached where an optical fiber is strained by predetermined strain power along with a thing to be measured is very complicated and installing to many installation parts especially The present condition was also that there is a problem that the installation takes a great labor and time, and it is required further that the strain state of the optical fiber after installation should be adjusted easily.

[0006] [this invention / the thing which was made in view of the above-mentioned situation, and curved to be measured] Can attach with very easily and sufficient accuracy, can measure distortion with high precision, and even if things to be measured are a large number, can install easily, can perform good Measurement Division, and further it is possible to adjust a strain state easily -- moreover -- low -- it aims at offering a cost distortion measuring device and its installation method.

[0007]

[Means for solving problem] In order to attain the above-mentioned purpose, [a distortion measuring device according to claim 1] The optical fiber for sensors which has a light source and the Bragg greeting part which opens a crevice, is arranged along with a thing to be measured, and reflects the light of a specific wavelength according to the degree of shrinkage of the light from said light source, [light / which was reflected in said Bragg greeting part of this optical fiber for sensors] It is the distortion measuring device which has the measuring instrument which detects elasticity of said optical fiber for sensors, and measures distortion of said thing to be measured based on the detection result of elasticity of said optical fiber for sensors. The intermediate part which the both ends of said optical fiber for sensors are supported by the supporter fixed to said thing to be measured, and contains said Bragg greeting part is characterized by being inserted in the tubed protection tube which has the flexibility fixed to said thing to be measured.

[0008] That is, since it is the structure where the intermediate part containing the Bragg greeting part of the optical fiber for sensors was covered with the protection tube, the Bragg greeting part which detects distortion can be protected certainly. Furthermore, the optical fiber for sensors which could learn and arrange this protection tube in the form of a thing to be measured, and made by this the protection tube which has flexibility insert in this protection tube since it was made to fix to a thing to be measured can be arranged with sufficient accuracy along with a thing to be measured. That is, since the optical fiber for sensors is arranged along with the hole of the protection tube fixed to the surface which is the Measurement Division side [thing / to be measured] of distortion even if it is a case as the surface of a thing to be measured is curving the shape of a U character, and in the shape of an S character The state where this optical fiber for sensors was made to arrange along the Measurement Division side of a thing to be measured can be made to be able to support, and the good Measurement Division result can be obtained.

[0009] The distortion measuring device according to claim 2 is characterized by forming said protection tube from resin in the distortion measuring device according to claim 1.

[0010] That is, when it meets to a thing to be measured and fixes to it, this protection tube can be learned from that form, can be changed easily, and can be made to fix, since the protection tube is formed from resin. And damage by sliding with the optical fiber for sensors inserted in the protection tube can also be suppressed.

[0011] The distortion measuring device according to claim 3 is characterized by adhesion fixation of said protection tube being carried out by adhesion material at said thing being measured in the distortion measuring device according to claim 1 or 2.

[0012] That is, since the protection tube is pasted up on the thing to be measured by adhesion material, as compared with the fastener means by screw clamp fixation etc., the labor concerning the fixed work can be reduced sharply.

[0013] A distortion measuring device according to claim 4 is set to the distortion measuring device of Claim 1 -3 given in any 1 clause. The optical fiber for distortion Measurement Division which connected said two or more optical fibers for sensors supported, respectively to said two or more things to be measured by the optical fiber for transmission is connected to said measuring instrument. It is characterized by detecting elasticity of said optical fiber for sensors of said optical fiber for distortion Measurement Division, respectively, and performing Measurement Division of distortion of said thing to be measured by this measuring instrument.

[0014] Thus, since two or more optical fibers for sensors use the optical fiber for distortion Measurement Division which was connected by the optical fiber for transmission and made into one By changing the wavelength of the catoptric light in the Bragg greeting part of each optical fiber for sensors, it is advantageous to Measurement Division of distortion of the thing which could measure distortion of many things to be measured and were especially arranged over a long distance by one optical fiber for distortion Measurement Division to be measured.

[0015] A distortion measuring device according to claim 5 is set to the distortion measuring device of Claim 1 -4 given in any 1 clause. [said supporter which the screw part which has a screw was prepared in the both ends of said optical fiber for sensors, and was fixed to said thing to be measured] By having ****** in which said screw part is screwed, and making said screw part screw in said supporter Said optical fiber for sensors is arranged along with said thing to be measured, and the screw of said screw part screwed mutually and ****** of said supporter are characterized by being mutually considered as the reverse screw at the both ends of said optical fiber for sensors.

[0016] That is, by making the screw part of the both ends of the optical fiber for sensors which has a Bragg greeting part screw in the supporter fixed to the thing to be measured Since the state where the crevice was opened along with the thing to be measured can be made to support the optical fiber for sensors very easily and the screw of a screw part and ****** of the supporter are moreover used as the reverse screw at both ends By rotating the optical fiber for sensors, it can be made to be able to expand and contract, without twisting the optical fiber for sensors in the state where the thing to be measured was made to support very easily, and the tension can be adjusted. Thereby, even if things to be measured are a large number, the optical fiber for sensors can be easily supported in a thing to be measured by predetermined tension in a short time.

[0017] The optical fiber for sensors which has the Bragg greeting part which the installation method of a distortion measuring device according to claim 6 opens a crevice, is arranged along with a light source and a thing to be measured, and reflects the light of a specific wavelength according to the degree of shrinkage of the light from said light source, [light / which was reflected in said Bragg greeting part of this optical fiber for

sensors] It is the installation method of the distortion measuring device which has the measuring instrument which detects elasticity of said optical fiber for sensors, and measures distortion of said thing to be measured based on the detection result of elasticity of said optical fiber for sensors. Said optical fiber for sensors is made to insert in the tubed protection tube which has flexibility beforehand. While putting said protection tube on the perimeter of the intermediate part containing said Bragg greeting part and fixing this protection tube to said thing to be measured, said thing to be measured is made to support the both ends of said optical fiber for sensors, and it is characterized by making a crevice open and arrange along with said thing to be measured.

[0018] Thus, since the intermediate part containing the Bragg greeting part of the optical fiber for sensors is made to insert in the tubed protection tube which has flexibility beforehand, this optical fiber for sensors can be protected certainly, and the damage at the time of conveyance and installation can be prevented especially certainly. And since the protection tube which has flexibility is made to fix to a thing to be measured and a thing to be measured is made to support the both ends of the optical fiber for sensors Even if it is a case as the surface of a thing to be measured is curving the shape of a U character, and in the shape of an S character The state where the optical fiber for sensors was made to arrange along the Measurement Division side of a thing to be measured by the inner skin of the protection tube fixed to the surface which is the Measurement Division side [thing / to be measured] of distortion can be made to be able to support, and the good Measurement Division result can be obtained.

[0019]

[Mode for carrying out the invention] The distortion measuring device of this invention and the example of an embodiment of the installation method are hereafter explained with reference to Drawings. In drawing 1 , a mark 1 is the distortion measuring device of this example of an embodiment. This distortion measuring device 1 has two or more optical fibers 2 for distortion Measurement Division, and the optical fiber 2 for these distortion Measurement Division is connected to the optical channel selector 3. A light source 5 and the many wave meters (measuring instrument) 6 are connected to this optical channel selector 3 through the circulator 4.

[0020] The Measurement Division light from a light source 5 is sent to the optical channel selector 3 through a circulator 4, and is sent to the optical fiber 2 for distortion Measurement Division chosen by the optical channel selector 3 of two or more optical fibers 2 for distortion Measurement Division. And the catoptric light from the optical fiber 2 for distortion Measurement Division to which this Measurement Division light was sent is sent to the many wave meters 6 through a circulator 4 from the optical channel selector 3.

[0021] Next, the optical fiber 2 for distortion Measurement Division is explained. As shown in drawing 2 , the optical fiber 2 for distortion Measurement Division has two or more optical fibers 11 for sensors, and is connected by the optical fiber 12 for transmission between optical fiber 11 comrades for these sensors and the optical fiber 11 for sensors, and the optical channel selector 3.

[0022] The optical fiber 11 for these sensors was attached to the thing S to be measured, and measures distortion of these measuring thing S. As shown in drawing 3 and drawing 4 , a pair of supporters 13 which opened the interval and were installed are formed in the thing S to be measured, and it is supported by the state where the optical fiber 11 for sensors of the optical fiber 2 for distortion Measurement Division opened the

crevice in these supporters 13 along with the thing S to be measured.

[0023] This optical fiber 11 for sensors is inserted in the tubed protection tube 10 which has the flexibility formed from resin, such as polyimide and Teflon (registered trademark), for example. And adhesion fixation of this protection tube 10 is carried out by adhesion material on the surface of the thing S to be measured. In addition, what was formed as a protection tube 10 from the metal material which has flexibility is usable.

[0024] As shown also in drawing 5 , [the optical fiber 11 for sensors] It welds and connects with those both ends, the optical fiber 12 for transmission covered with the covering material 12a is made into one optical fiber 2 for distortion Measurement Division to them, and the screw part 16 by which the screw 15 was formed in that perimeter is formed in this weld part 14. and as for this optical fiber 11 for sensors, the screw part 16 in which that screw 15 was formed was formed in the thing S to be measured -- it is acceptable supporter 13, and a screw 17 is stuffed and it is supported.

[0025] Here, the screw part 16 of the both ends of this optical fiber 11 for sensors reaches screw 15, are acceptable supporter 13, and let the screw 17 of each other be a reverse screw. That is, the amount of screwing to the supporter 13 of the screw part 16 of both ends changes, and it can be made to expand and contract by rotating the optical fiber 11 for sensors now, without twisting the optical fiber 11 for sensors.

[0026] The base supporter 13a with which the supporter 13 was fixed to the thing S to be measured as shown in drawing 6 , It consists of cover supporters 13b fixed to the upper part of this base supporter 13a with Screw 13c. It is supported by the state where the screw part 16 was acceptable supporter 13, and was screwed in the screw 17, by it base supporter 13a Being acceptable, putting the cover supporter 13b on a screw 17, where the screw part 16 is arranged, and fixing and unifying with Screw 13c.

[0027] The optical fiber 11 for sensors has the fiber Bragg grating part (henceforth the FBG section) 21 in the intermediate part. [the core 11b formed in the center of Clad 11a] as this FBG section 21 carries out Bragg diffraction, and reflects light and it is shown in drawing 7 Several light reflector parts 22 from which a refractive index differs to other portions with processing methods, such as the laser radiation method for irradiating laser beams from the side and changing a refractive index, are formed.

[0028] That is, if light enters into this FBG section 21, it reflects in each light reflector part 22 of the FBG section 21, and a part of that light will interfere mutually, it will suit in slight strength, and will be returned as comparatively big catoptric light.

[0029] And when this FBG section 21 is expanded and contracted, the interval of light reflector part 22 comrades will change, and the wavelength of the catoptric light returned by interfering mutually will also change in connection with this. That is, by detecting change of the wavelength of the catoptric light from this FBG section 21, the amount of elasticity of the optical fiber 11 for sensors is deduced, and distortion of the thing S with which this optical fiber 11 for sensors was formed to be measured is called for.

[0030] in addition, [each optical fiber 11 for sensors prepared in each optical fiber 2 for distortion Measurement Division] Predetermined tension different, respectively is given beforehand, thereby, the wavelength of the catoptric light in each optical fiber 11 for sensors can be kept from overlapping, and the catoptric light of each optical fiber 11 for sensors in each optical fiber 2 for distortion Measurement Division can be specified now,

respectively. That is, it sets in [as shown in drawing 8 and drawing 9 / which is the range of the wavelength of a measurable light / measurable] the wavelength range Ws (refer to drawing 8). Reflective wavelength range Wb (s) (refer to drawing 9) which are the ranges of a wavelength including change by distortion of the thing S of the catoptric light from the optical fiber 11 for sensors to be measured are kept from overlapping mutually.

[0031] Moreover, the optical fiber 11 for sensors which has the FBG section 21 of the above-mentioned structure is covered with the covering 23 which the perimeter side becomes from ultraviolet curing nature resin. [furthermore, the perimeter side of the covering / in / in this optical fiber 11 for sensors / the formation portion of the FBG section 21 / 23] Adhesion fixation of the reinforcing member 24 of the shape of a tube which consists of resin, such as a plastic, is carried out, the hardness of FBG section 21 portion is raised by this reinforcing member 24, and the elastic modulus is relatively made lower than other portions.

[0032] Next, the case where the thing S to be measured is made to support the optical fiber 11 for sensors of the above-mentioned optical fiber 2 for distortion Measurement Division is explained. First, the optical fiber 11 (refer to drawing 10) for sensors is made to insert in the protection tube 10 beforehand (refer to drawing 11).

[0033] Subsequently, the screw part 16 is attached to the weld part 14 of this optical fiber 11 for sensors (refer to drawing 12). In addition, he is prepared in the screw part 16 by Stoppa 25 at the protection tube 10 side, and by this The open end of the protection tube 10 is closed by this Stoppa 25, invasion of the foreign substance into the protection tube 10 etc. is prevented, and the optical fiber 11 for sensors is certainly protected.

[0034] On the other hand, the base supporter 13a which constitutes a supporter 13 is fixed to the thing S to be measured (refer to drawing 13). Arrange the screw part 16 of the both ends of the optical fiber 11 for sensors in the base supporter 13a fixed to the thing S to be measured (refer to drawing 14), and it sets to it at this state. Put the cover supporter 13b, fix with Screw 13c, and unify a supporter 13, and it is acceptable supporter 13, the screw part 16 is made to screw in a screw 17, and the optical fiber 11 for sensors is made to support along with the thing S to be measured (refer to drawing 15). Moreover, adhesion fixation of the protection tube 10 in which the optical fiber 11 for sensors was made to insert is carried out by adhesion material on the surface of the thing S to be measured.

[0035] If the adhesion material which carries out adhesion fixation hardens the protection tube 10 in the thing S to be measured, the optical fiber 11 for sensors will be rotated and the optical fiber 11 for sensors will be expanded by predetermined tension (refer to drawing 16).

[0036] The screw part 16 of the both ends of this optical fiber 11 for sensors reaches screw 15, and it is acceptable supporter 13 here, and [a screw 17] Since it is mutually considered as the reverse screw, by rotating the optical fiber 11 for sensors, the amount of screwing to the supporter 13 of the screw part 16 of both ends changes, and it is elongated, without twisting the optical fiber 11 for sensors.

[0037] By doing the above-mentioned work, a crevice is opened, the optical fiber 11 for sensors can be made to be able to support along with the thing S to be measured easily, and it can change into the state which can measure distortion. In addition, after installing the optical fiber 11 for sensors to the thing S to be measured as mentioned above, the upper part of the thing S having contained the optical fiber 11 for sensors to be measured is covered with the waterproof cover 26 if needed, and waterproofing processing is performed (refer to drawing

17).

[0038] And according to the distortion measuring device 1 of the above-mentioned structure, the Measurement Division light taken out from a light source 5 is sent to the optical channel selector 3 through a circulator 4, and is sent to the optical fiber 2 for distortion Measurement Division chosen by this optical channel selector 3. It is reflected in the FBG section 21 of the optical fiber 11 for sensors into which this Measurement Division light was sent and which was distorted and was supported by the thing S to be measured in the optical fiber 2 for Measurement Division, and is returned as catoptric light.

[0039] And direction is changed by a circulator 4, the catoptric light reflected in the FBG section 21 of the optical fiber 11 for these sensors is sent to the many wave meters 6, the catoptric light from each optical fiber 11 for sensors is detected with these many wave meters 6, and that state is displayed.

[0040] That is, distortion of the thing S with which each optical fiber 11 for sensors was supported to be measured is detectable from change of the wavelength of the catoptric light of each optical fiber 11 for sensors detected with these many wave meters 6. Moreover, in the optical channel selector 3, the optical fiber 2 for distortion Measurement Division is chosen in order, and is connected, and, thereby, distortion of the thing S in the optical fiber 2 for distortion Measurement Division of these plurality to be measured is always supervised.

[0041] Moreover, in the optical fiber 11 for sensors [the FBG section 21] Since an elastic modulus is relatively made low by the reinforcing member 24 prepared in the perimeter side as compared with other portions and elasticity is suppressed by it [in / which the amount of elasticity in the FBG section 21 accompanying distortion of the thing S to be measured is made small, and the range of change of the catoptric light from this FBG section 21 is made small, therefore is the range of the wavelength of a measurable light / measurable / the wavelength range Ws] More reflective wavelength ranges Wb can be formed and, thereby, the amount of installation of the optical fiber 11 for sensors which can be installed in one optical fiber 2 for distortion Measurement Division can be made to increase sharply.

[0042] Also when measuring distortion of a lot of things S to be measured thereby especially, while not preparing a lot of optical fibers 2 for distortion Measurement Division and being able to aim at sharp cost reduction, easy-ization of the arrangement work of the optical fiber 2 for distortion Measurement Division can be attained. Moreover, since many optical fibers 11 for sensors can be formed in one optical fiber 2 for distortion Measurement Division, it is advantageous to Measurement Division of distortion of a lot of things S especially prepared over a long distance to be measured.

[0043] Thus, since it is the structure where the intermediate part containing the FBG section 21 of the optical fiber 11 for sensors was covered with the protection tube 10 according to the above-mentioned distortion measuring device 1, the FBG section 21 which detects distortion can be certainly protected with the protection tube 10. Furthermore, [the protection tube 10 which has flexibility] since it was made to fix to the thing S to be measured This protection tube 10 can be learned and arranged in the form of the thing S to be measured, and, thereby, the optical fiber 11 for sensors made to insert in this protection tube 10 can be arranged with sufficient accuracy along with the thing S to be measured.

[0044] That is, as shown in drawing 18 , even if it is a case as the surface of the thing S to be measured is curving

the hole of the protection tube 10 by which adhesion fixation was carried out on the surface whose optical fiber 11 for sensors is the Measurement Division side [thing / S / to be measured] of distortion -- since it meets among them and is supported by the state where it was elongated, the state where this optical fiber 11 for sensors was made to arrange along the Measurement Division side of the thing S to be measured can be made to support

[0045] Moreover, when it meets to the thing S to be measured and fixes this protection tube 10 to it by forming the protection tube 10 from resin, it can learn from that form, can be made to be able to change easily, and can be made to fix. And damage by sliding with the optical fiber 11 for sensors inserted in the protection tube 10 can also be suppressed.

[0046] Furthermore, since it is the structure which pasted up the protection tube 10 on the thing S to be measured by adhesion material, as compared with the fastener means by screw clamp fixation etc., the labor concerning the fixed work can be reduced sharply.

[0047] Moreover, since two or more optical fibers 11 for sensors use the optical fiber 2 for distortion Measurement Division which was connected by the optical fiber 12 for transmission and made into one By changing the wavelength of the catoptric light in the FBG section 21 of each optical fiber 11 for sensors, it is advantageous to Measurement Division of distortion of the thing S which could measure distortion of many things S to be measured, and were especially arranged over a long distance by one optical fiber 2 for distortion Measurement Division to be measured.

[0048] Furthermore, by making the screw part 16 of the both ends of the optical fiber 11 for sensors which has the FBG section 21 screw in the supporter 13 fixed to the thing S to be measured Since the state where the crevice was opened along with the thing S to be measured can be made to support the optical fiber 11 for sensors very easily, it is moreover acceptable supporter 13 with the screw 15 of the screw part 16 and the screw 17 is used as the reverse screw at both ends By rotating the optical fiber 11 for sensors, it can be made to be able to expand and contract, without twisting the optical fiber 11 for sensors in the state where the thing S to be measured was made to support very easily, and the tension can be adjusted.

[0049] Thereby, even if the things S to be measured are a large number, the optical fiber 11 for sensors can be easily supported in a thing to be measured by predetermined tension in a short time.

[0050] And since the intermediate part containing the FBG section 21 of the optical fiber 11 for sensors is made to insert in the tubed protection tube 10 which has flexibility beforehand according to the installation method of the above-mentioned distortion measuring device 1 This optical fiber 11 for sensors can be certainly protected with the protection tube 10, and the damage at the time of conveyance and installation can be prevented especially certainly.

[0051] And since the protection tube 10 which has flexibility is made to fix to the thing S to be measured and the thing S to be measured is made to support the both ends of the optical fiber 11 for sensors [with the inner skin of the protection tube 10 which fixed the optical fiber 11 for sensors to the surface which is the Measurement Division side / thing / S / to be measured / of distortion] even if it is a case as the surface of the thing S to be measured is curving The state where it was made to arrange along the Measurement Division side of the thing S

to be measured can be made to be able to support, and the good Measurement Division result can be obtained.
[0052] In addition, the above-mentioned distortion measuring device 1 can be adapted for all the things that measure distortion, for example, not to mention buildings, such as steel structures, such as an iron bridge, and a building It can use, when measuring the distortion in the foundation and supervising diastrophism, such as land subsidence, or also when measuring distortion of the wing of an airplane, the body, etc.
[0053]
[Effect of the Invention] As mentioned above, according to the distortion measuring device and its installation method of this invention, the following effect can be acquired as explained. Since it is the structure where the intermediate part containing the Bragg greeting part of the optical fiber for sensors was covered with the protection tube according to the distortion measuring device according to claim 1, the Bragg greeting part which detects distortion can be certainly protected with a protection tube. Furthermore, the optical fiber for sensors which could learn and arrange this protection tube in the form of a thing to be measured, and made by this the protection tube which has flexibility insert in this protection tube since it was made to fix to a thing to be measured can be arranged with sufficient accuracy along with a thing to be measured. That is, since the optical fiber for sensors is arranged along with the hole of the protection tube fixed to the surface which is the Measurement Division side [thing / to be measured] of distortion even if it is a case as the surface of a thing to be measured is curving the shape of a U character, and in the shape of an S character The state where this optical fiber for sensors was made to arrange along the Measurement Division side of a thing to be measured can be made to be able to support, and the good Measurement Division result can be obtained.
[0054] When it meets to a thing to be measured and fixes to it, this protection tube can be learned from that form, can be changed easily, and can be made to fix, since the protection tube is formed from resin according to the distortion measuring device according to claim 2. And damage by sliding with the optical fiber for sensors inserted in the protection tube can also be suppressed.
[0055] Since the protection tube is pasted up on the thing to be measured by adhesion material according to the distortion measuring device according to claim 3, as compared with the fastener means by screw clamp fixation etc., the labor concerning the fixed work can be reduced sharply.
[0056] Since two or more optical fibers for sensors use the optical fiber for distortion Measurement Division which was connected by the optical fiber for transmission and made into one according to the distortion measuring device according to claim 4 By changing the wavelength of the catoptric light in the Bragg greeting part of each optical fiber for sensors, it is advantageous to Measurement Division of distortion of the thing which could measure distortion of many things to be measured and were especially arranged over a long distance by one optical fiber for distortion Measurement Division to be measured.
[0057] By making the screw part of the both ends of the optical fiber for sensors which has a Bragg greeting part screw in the supporter fixed to the thing to be measured according to the distortion measuring device according to claim 5 Since the state where the crevice was opened along with the thing to be measured can be made to support the optical fiber for sensors very easily and the screw of a screw part and ****** of the supporter are moreover used as the reverse screw at both ends By rotating the optical fiber for sensors, it can be made to be

able to expand and contract, without twisting the optical fiber for sensors in the state where the thing to be measured was made to support very easily, and the tension can be adjusted. Thereby, even if things to be measured are a large number, the optical fiber for sensors can be easily supported in a thing to be measured by predetermined tension in a short time.

[0058] Since the intermediate part containing the Bragg greeting part of the optical fiber for sensors is made to insert in the tubed protection tube which has flexibility beforehand according to the installation method of a distortion measuring device according to claim 6 This optical fiber for sensors can be certainly protected with a protection tube, and the damage at the time of conveyance and installation can be prevented especially certainly. And since the protection tube which has flexibility is made to fix to a thing to be measured and a thing to be measured is made to support the both ends of the optical fiber for sensors Even if it is a case as the surface of a thing to be measured is curving, the state where the optical fiber for sensors was made to arrange along the Measurement Division side of a thing to be measured by the inner skin of the protection tube fixed to the surface which is the Measurement Division side [thing / to be measured] of distortion can be made to be able to support, and the good Measurement Division result can be obtained.

[Brief Description of the Drawings]

[Drawing 1] It is the outline composition figure of the distortion measuring device explaining the distortion measuring device and its installation method of the example of an embodiment of this invention.

[Drawing 2] It is a schematic view explaining the optical fiber for distortion Measurement Division which constitutes the distortion measuring device of the example of an embodiment of this invention.

[Drawing 3] It is a top view explaining the attachment state to the thing of the optical fiber for sensors of the optical fiber for distortion Measurement Division of the distortion measuring device of the example of an embodiment of this invention to be measured.

[Drawing 4] It is a sectional side elevation explaining the attachment state to the thing of the optical fiber for sensors of the optical fiber for distortion Measurement Division of the distortion measuring device of the example of an embodiment of this invention to be measured.

[Drawing 5] It is a perspective view explaining the structure of the optical fiber for sensors of the distortion measuring device of the example of an embodiment of this invention.

[Drawing 6] It is a perspective view explaining the structure of the supporter which supports the optical fiber for sensors of the distortion measuring device of the example of a form of operation of this invention.

[Drawing 7] It is an outline perspective view explaining the structure of the FBG section prepared in the optical fiber for sensors of the distortion measuring device of the example of a form of operation of this invention.

[Drawing 8] It is a graphical representation explaining distribution of the catoptric light [in / it is distorted and / a measuring device] using an optical fiber.

[Drawing 9] It is a graphical representation explaining distribution of the catoptric light [in / it is distorted and /

a measuring device] using an optical fiber.

[Drawing 10] It is the side view of the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention.

[Drawing 11] It is the side view of the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention.

[Drawing 12] It is the side view of the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention.

[Drawing 13] It is the sectional side elevation explaining the installation method of the distortion measuring device of the example of an embodiment of this invention of a thing to be measured.

[Drawing 14] It is the sectional side elevation of the thing with which the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention was supported to be measured.

[Drawing 15] It is the sectional side elevation of the thing with which the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention was supported to be measured.

[Drawing 16] It is the sectional side elevation of the thing with which the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention was supported to be measured.

[Drawing 17] It is the sectional side elevation of the thing with which the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention was supported to be measured.

[Drawing 18] It is the sectional side elevation of the thing with which the optical fiber for sensors explaining the installation method of the distortion measuring device of the example of an embodiment of this invention was supported to be measured.

[Explanations of letters or numerals]

1 Distortion Measuring Device

2 Optical Fiber for Distortion Measurement Division

5 Light Source

6 Many Wave Meters (Measuring Instrument)

10 Protection Tube

11 Optical Fiber for Sensors

12 Optical Fiber for Transmission

13 Supporter

15 Screw

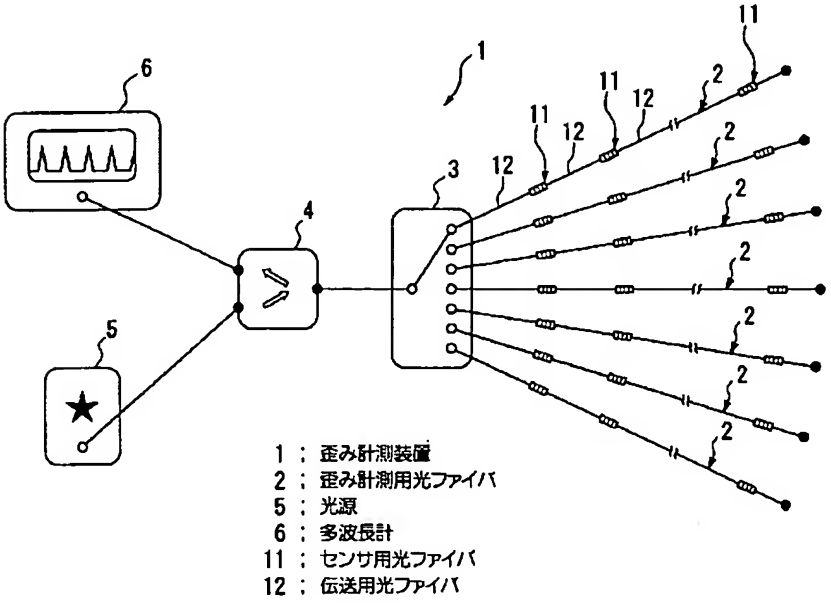
16 Screw Part

17 ******

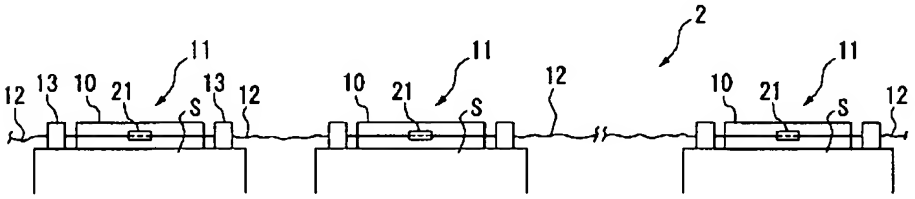
21 The FBG Section (Bragg Greeting Part)

S A thing to be measured

[Drawing 1]

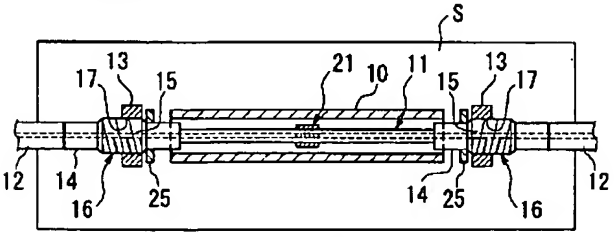


[Drawing 2]



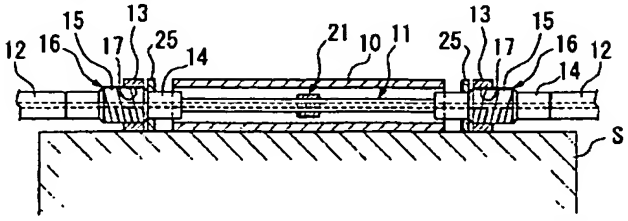
2 ; 歪み計測用光ファイバ
10 ; 保護チューブ
11 ; センサ用光ファイバ
12 ; 伝送用光ファイバ
13 ; 支持部
21 ; FBG部
S ; 被計測物

[Drawing 3]



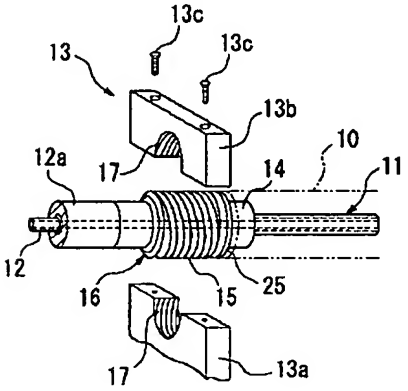
10 ; 保護チューブ
11 ; センサ用光ファイバ
12 ; 伝送用光ファイバ
13 ; 支持部
15 ; おねじ
16 ; ねじ部
17 ; めねじ
21 ; FBG部
S ; 被計測物

[Drawing 4]



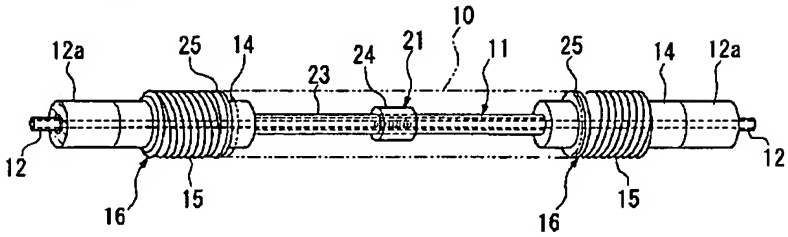
10 ; 保護チューブ　16 ; ねじ部
11 ; センサ用光ファイバ　17 ; めねじ
12 ; 伝送用光ファイバ　21 ; FBG部
13 ; 支持部　S ; 被計測物
15 ; おねじ

[Drawing 6]



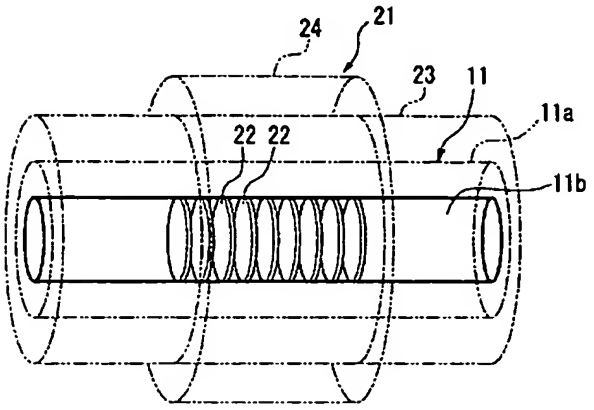
10 ; 保護チューブ
11 ; センサ用光ファイバ
12 ; 伝送用光ファイバ
13 ; 支持部
15 ; おねじ
16 ; ねじ部
17 ; めねじ

[Drawing 5]



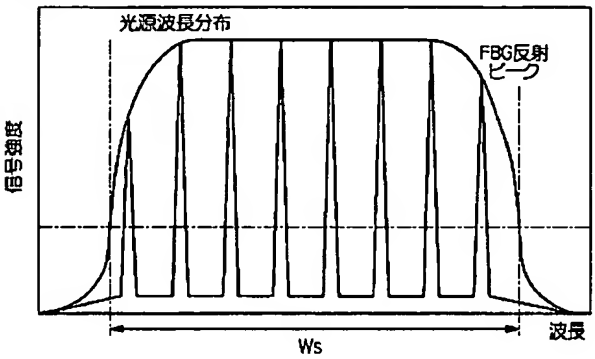
10 ; 保護チューブ
11 ; センサ用光ファイバ
12 ; 伝送用光ファイバ
15 ; おねじ
16 ; ねじ部
21 ; FBG部

[Drawing 7]

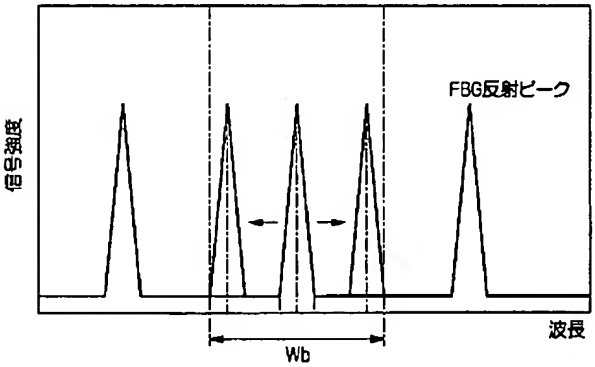


11 : センサ用光ファイバ
21 : FBG部

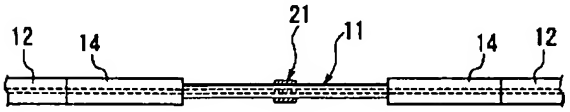
[Drawing 8]



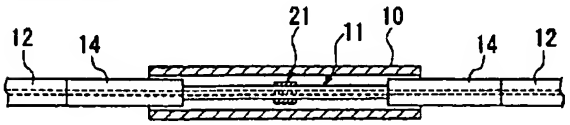
[Drawing 9]



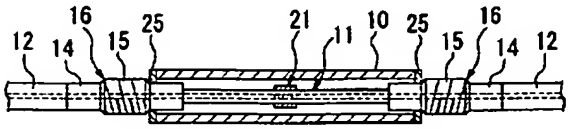
[Drawing 10]



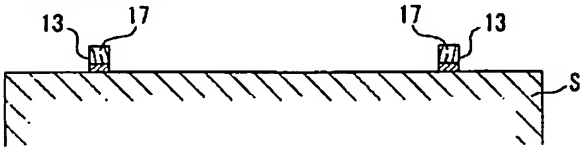
[Drawing 11]



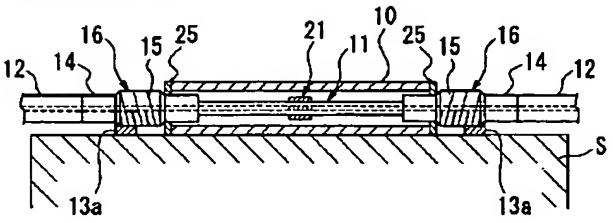
[Drawing 12]



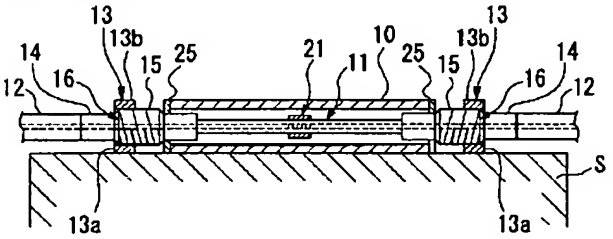
[Drawing 13]



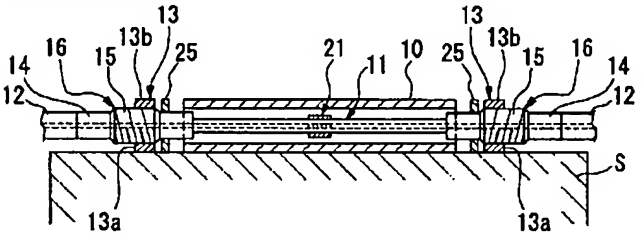
[Drawing 14]



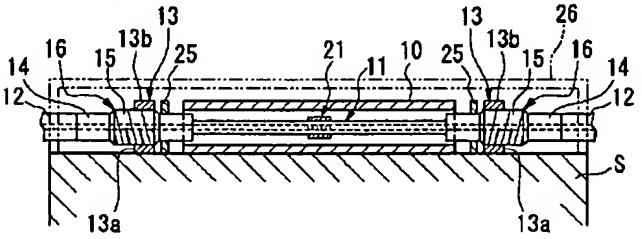
[Drawing 15]



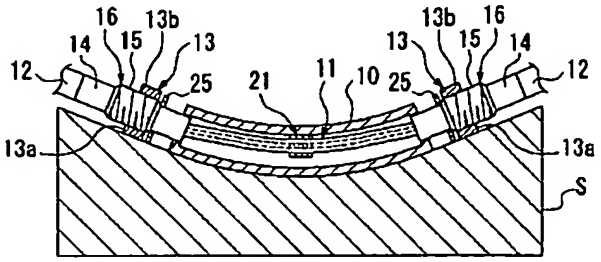
[Drawing 16]



[Drawing 17]



[Drawing 18]



[Translation done.]